A new recession-dating algorithm for South Africa

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ABSTRACT

The SA Reserve Bank (SARB) regularly determines the upper and lower turning points of the South African business cycle, but this is only completed after all the relevant information has been obtained, confirmed and analysed, causing a lengthy time lag between the actual determination and the event. The current research aimed to design a recession-dating algorithm, which could allow the Bureau for Economic Research (BER) to make accurate calls on business cycle turning points substantially sooner after the event than is the case with the official SARB determination, which typically lags actual turning points by 18 to 24 months. The proposed algorithm includes, as a point of departure, the advance signals given by the yield spread (between 3-month and 10-year government bonds), as well as a consideration of the local moments of five high-frequency economic time series. The turning point signals provided by these indicators (and after the application of censoring rules) are integrated by reconciling the differences through the use of the median date in order to derive true business cycle turning points. The algorithm was tested for the five recessions experienced over the 1981 to 2013 period. It was found that the algorithm could be applied successfully in calling the business cycle turning points over this 32-year period avoiding any false positives. A high degree of accuracy was also obtained, i.e. a median two month lag in respect of upper turning points (or peaks) of the SARB-determined business cycle and a one month lead in respect of lower turning points (i.e. troughs). The algorithm will not only allow the BER to make close calls on business cycle turning points, it will be able to do this with a much shorter time delay following actual turning points compared to the SARB's official determination.

Keywords: Business cycles, turning points, quantitative analysis of business cycles
JEL codes: C41, E32

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Introduction

A small but not insignificant detail contained in the SA Reserve Bank (SARB) *Quarterly Bulletin* (released towards the end of May 2011) pertains to the officially determined lower turning point of the most recent business cycle downswing (or recession), namely August 2009, i.e. 22 months after the fact. Using a comprehensive set of statistical and econometric analysis, the SARB regularly determines the upper and lower turning points of the South African (SA) business cycle, but this is only completed after all the relevant information has been obtained and confirmed, causing a lengthy time lag between the actual determination and the event.

As business cycle turning points are critical in the world of economic forecasting, business operational planning and economic policy making, there is a need for a more timeous indicator of business cycle turning points. As close as possible to the event, by interrogating high-frequency data (inter alia, the BER's business opinion survey data), it may be possible to 'pre-empt' the SARB's business cycle turning point determination.

This is the objective in the current paper, i.e. an investigation into the viability of a new recession-dating algorithm for South Africa. As such – it needs to be emphasized – it is not the objective to develop a *leading* indicator (or predictor) of business cycle turning points but rather an algorithm which will confirm business cycle turning points as close as possible (depending on the availability of the relevant data) after the event. This will remain useful information for the economic forecaster, business executive, investor and economic policy maker. Exploring the possibility of a 'short-hand leading indicator' or real-time business cycle indicator is the subject of future research.

Following the method applied by Leamer (*What's A Recession, Anyway?* NBER Working Paper 14221, August 2008) in compiling such an algorithm for the US economy, this paper discusses the investigation into a similar algorithm for the SA economy. The investigation commences with a brief consideration of the theoretical issues regarding the dating of business cycle turning points. In the second section, the Leamer methodology is briefly explained, as well as the so-called censoring rules to be applied, and in the third and main section, each of the potential time series to be included in the algorithm are briefly discussed – individually and then combined in the fourth section, including an exposition of the suggested algorithm. Some concluding remarks follow in the final section.

Dating business cycle turning points – theoretical issues

Business cycle research concerns itself with studying the *'recurrent periods of (relative) expansion and contraction'* in the economic activities of modern nations. Burns & Mitchell (1946) are usually accredited with the classical conceptualization of the business cycle. As a modern phenomenon, the business cycle is actually never observed as such, but is only discernable by applying analytical tools to time series economic data and by identifying/ extracting those fluctuations we call the business cycle from other (spurious) fluctuations. In the words of Burns & Mitchell, [so that the business cycle can] *"… be seen through a cloud of witnesses only by the eye of the mind"* (Burns & Mitchell quoted in du Plessis, 2006: 3-4).

In the economics field this ability and analytical activity is highly valuable, given the *'unceasing round of the business cycle'* (Burns & Mitchell, 1946). From the classical perspective of the business cycle then a central issue becomes the separation/ identification of successive periods of expansion and contraction in economic activity, *i.e. in locating turning points* – in which calendar month can it be stated with a reasonable degree of certainty that the broader economy moved from expansion to recession, for instance (or *vice versa*)?

This is not only esoteric information for the analyst, but critical to know for the business executive, investor or (economic) policy maker. To the former its budget and strategic planning can be strongly influenced by what phase of the business cycle the broader economy is embarked upon. For the economic policy maker it is also important to know as he or she aims to smooth economic fluctuations, in turn, to facilitate business planning in an indirect sense, but also more directly in understanding the economic linkages and transmission mechanisms in order to design and sequence the implementation of monetary and fiscal policies. The cyclical development of economic activity is therefore a central issue in economics in general.

Business cycle research has evolved over the years and analysts have tended to move away from the classical (Burns & Mitchell) conceptualization of the business cycle to the contemporary preference in calculating so-called *'deviation or growth cycles'*, i.e. the business cycle is understood as the cyclical component of a reference economic time series (such as GDP) when the permanent trend component is accounted for/ has been removed[2]. In other words, the business cycle is provided through the creation of a new stochastic variable being the deviation of the reference series from its long-term trend. An expansion phase of the business cycle would be the time period during which

[2] The need to focus on *growth rate cycles* arose during the post-World War II period with the reconstruction of the European and Japanese economies, a time period characterized by uninterrupted economic expansion (Japan, for instance, experienced one classical recession between 1954 and 1992).

the relevant reference series grows faster than trend and the contraction period (or more accurately, the recessionary period) being the time during which the reference series grew lower than trend.

In the classical conceptualization of the business cycle two aspects are critical: one, the *duration* of the peak-to-peak (or trough-to-trough) business cycle, and, *secondly*, the fact that successive periods of expansion and contraction in aggregate economic activity were viewed in *absolute terms.* For instance, if GDP was the reference economic time series reflecting the movement of aggregate economic activity, a downswing phase of the business cycle would be one where the *'level'* of real GDP contracted, i.e. also described as a so-called *'level-recession'*[3]. Regarding the *duration* of a business cycle, it was observed that a full business cycle could not be shorter than 15 months and was rarely longer than twelve years (Du Plessis, 2006)[4].

In the contemporary conceptualization of the business cycle, or more accurately, so-called *growth cycles*, it is possible, for instance, that the reference time series reflecting the movement of broad economic activity, continue expanding in absolute terms during a recessionary period. Should the *rate of expansion* be below the long-term trend rate, a so-called *'growth recession'* is identified. Likewise, any expansion faster than trend is defined as an expansion phase of the business (or growth) cycle. It may be particularly difficult to identify a classical business cycle in economies that experience steep expansions with a long duration (e.g. Japan in the 1980s) in which case the identification of so-called *growth cycles* may be more appropriate, i.e. identifying periods of *relative* expansion and slowdown (see Du Plessis, 2006).

Analysts tend to define so-called *censoring and other logical rules* in order to determine true business cycle turning points, i.e. to discard fluctuations in economic activity not related to the underlying business cycle – *see below*. Typically restrictions are placed on the *duration* of both the *phase* (trough-to-peak or peak-to-trough) and *complete length* of the business cycle (peak-to-peak or trough-to-trough). Furthermore, the specified reference economic time series has to be representative of the broader economy. Should selected time series be analysed to determine business cycle turning points, it will be necessary that the clear majority of these time series' turning points cluster together in order to indicate a true business cycle turning point; *see below*.

[3] Originally, long time series of broad economic activity such as GDP were not available, which led to the calculation of composite reference time series which could reveal the evolution of the business cycle.

[4] This is in line with the pioneering work of Burns & Mitchell at the NBER and later extended by Geoffrey Moore of the *Economic Cycle Research Institute (ECRI)* having established that a business cycle is rarely shorter than one year or longer than 10-12 years – see Achuthan & Banerji, 2004: 72. This is part of the formal definition of a business cycle.

This is an extremely important point in business cycle research. While every business cycle contraction or expansion is unique, the study of turning points has revealed common elements regarding the sequencing of events at the time of business cycle turning points. A single indicator may not be able to accurately identify a general business cycle turning point (in aggregate economic activity); however, when analyzing a range of economic indicators (including composite leading, coincident and lagging indices) it is possible to detect this *durable sequencing* of developments and reliably identify turning points in the business cycle, alternatively shifts in economic activity from expansion to contraction, or *vice versa*[5].

Apart from the issues of classical business cycles and growth cycles and censoring and logical rules in determining business cycle turning points, there is the theoretical issue of what causes the business cycle. More specifically, the question is posed whether business cycles have an *endogenous* regularity/ momentum or are business cycle fluctuations caused by *exogenous* shocks? This is a deep theoretical debate, for instance, bordering on the issue of the relative efficacy of monetary and fiscal policies aimed at influencing or smoothing business cycle fluctuations (as opposed to *laissez faire* approaches) and is not entirely relevant in the current paper.

The business cycle analyst is interested in identifying the co-movement of economic time series in particular phases of the business cycle and to what extent these fluctuations correspond from the one cycle to the next. Apart from understanding the development of business cycles, the dating of turning points, when an economy moves from expansion to contraction (or *vice versa*), is a critical issue. As noted, the business executive, investor and economic policy maker, amongst other, have a keen interest in this knowledge. Much work has been conducted in this field and the current paper draws on this work in order to investigate the construction of a recession-dating algorithm for the SA economy. The investigation commences with a brief discussion of the methodology.

Methodology

Leamer's (2008) objective was to compile an algorithm that would reproduce the business cycle turning points as identified by the National Bureau of Economic Research (NBER) in respect of the USA economy. He identifies a number of monthly time series to include in his algorithm, namely industrial production, payroll employment and the unemployment rate. Leamer established that in all ten US recessions (as determined by the NBER) during the post-war period, there were months that all three these time series were in recessionary periods, i.e. they satisfied some pre-determined

[5] Achuthan & Banerji (2004: 112) refer to the three P's, i.e. turning points in any economic time series need to be *pronounced, pervasive and persistent* in order to qualify as a reliable indicator of a potential turning point. Pervasiveness refers to the fact that the *majority* of the selected indicators need to reflect (pronounced) turning points and for long enough, at least four to five months.

recessionary threshold. He therefore compiled an algorithm which could reproduce the 'official' business cycle turning points of the US economy. The algorithm was compiled as follows:

- The *first step* is to identify the recessionary periods of the selected time series. For each time series, periods that would satisfy a pre-determined recession threshold, have to be identified. He suggests calculating the 6-month rate of change in the time series and then to identify a threshold below which the relevant time series indicates a recessionary period. The following recession thresholds were determined and specified, i.e. when all three these conditions were met, the US economy was found to be in recession:

  - log(payroll/payroll(-6)) < -0.005;
  - log (ind_prod/ind_prod(-6)) < -0.03; and
  - log(unemployment rate/unemployment rate(-6)) > 0.8

  In order to qualify as a recession the threshold condition has to apply not only for one of the time series, but also for the other selected time series. *The key in the first step of the algorithm is therefore to determine the recessionary thresholds for each of the selected time series considered in the exercise*.

- The *second step* is to identify the peak and trough dates of each selected time series. Once again, for each individual time series, Leamer suggests calculating the second derivative: when the second derivative during a recessionary period (i.e. with the first derivative below the threshold) is maximally negative, a *peak* is identified; conversely, when the second derivate during a recessionary period is maximally positive, a *trough* is identified. In logarithmic notation: when the second derivative of the time series y, namely log y(t+6)/y(t) – log y(t)/y(t-6) is negative, the present growth rate is to be followed by a lower growth rate, i.e. when we near a recession ahead; in fact, Leamer suggests when this second derivative is maximally negative, a peak is identified in time series y. Conversely, when log y(t+6)/y(t) – log y(t)/y(t-6) is positive, it implies that a period of higher growth is going to follow the current rate of (low) growth, i.e. the end of the recession is approached; in fact, when this second derivative is maximally positive, a trough in the time series y is identified. Due to volatility in some economic time series, it is possible that spurious fluctuations not related to the underlying business cycle development give false turning point signals. In order to eliminate such spurious signals, it is necessary to apply *censoring rules*, i.e. a turning point signal first has to comply with these censoring rules before it can be regarded as a true business cycle turning point signal – *see the subsection below*.

- *Thirdly*, with the time series selected, the peak and trough dates of each time series determined, business cycle turning points can be determined by reconciling the peak and trough differences by using the median of the various suggested dates.

The objective with the current paper is to investigate high frequency time series in respect of the South African economy, which may qualify as reliable indicators of the business cycle turning points as calculated by the SARB and then to compile a recession-dating algorithm following Leamer's method. The aim is to improve on the time lag involved in the SARB's determination and the actual business cycle turning point. The investigation is conducted over the period 1975 to 2013. Commencing with a lower turning point in December 1977, the SA economy experienced five trough-to-trough business cycles over this period *(up to and including August 2009; see Table 1)*.

In the section below, the time series investigated for inclusion in a recession-dating algorithm for SA are briefly discussed. The time series have been selected on the basis of closest predictors of the business cycle turning points as identified by the SARB. The idea is to determine the peak and trough dates of the individual time series and then to reconcile the differences by considering the median of each upper and lower turning point as the true business cycle turning point.

Table 1: South African business cycle phases: September 1974 to December 2013

	Downswing phases	**Length** (months)	**Depth** (peak-to-trough)[1]	**Upswing phases**	**Length** (months)	**Height** (trough-to-peak)[1]
1.	Sept 74 – Dec 77	40	+2.9%	Jan 78 – Aug 81	44	+21.2%
2.	Sept 81 – Mar 83	19	-4.7%	Apr 83 – Jun 84	15	+8.1%
3.	Jul 84 – Mar 86	21	-3.2%	Apr 86 – Feb 89	35	+9.5%
4.	Mar 89 – May 93	51	-3.7%	Jun 93 – Nov 96	42	+14.9%
5.	Dec 96 – Aug 99	33	+3.2%	Sep 99 – Nov 07	99	+43.6%
6.	Dec 07 – Aug 09	21	-0.6%	Sep 09 – ?	51+	?

1. Percentage change in the level of GDP at constant 2005 prices.

Source: SA Reserve Bank *Quarterly Bulletin*, December 2013

The following time series have been investigated: manufacturing production volumes (both official StatsSA physical volume of production index and BER business opinion survey data); manufacturing order volumes (BER); manufacturing factory working hours (BER); manufacturing capacity utilization (StatsSA); wholesale sales volume (StatsSA and BER); retail sales volume (StatsSA and BER); new vehicle sales volume (SARB and BER); non-agricultural employment (StatsSA/SARB); business confidence (BER); consumer confidence (BER); manufacturing finished goods stocks (BER); wholesale stocks (BER); retail stocks (BER); motor trade stocks (BER); ABSA house price index (adjusted for inflation); and the JSE All-Share Price Index (ALSI)[6].

Generally it was found that the data tend to be more volatile compared to the relatively stable US monthly data. Where data proved 'noisy', a five-month centered moving average was considered in the analysis. Furthermore, the BER quarterly business opinion survey data was converted to monthly frequencies assuming the same quarterly value for each month of the quarter; in the case of noisy survey data, five-month moving averages were calculated. It was also necessary to consider nine-month rates of change in the BER's quarterly survey data instead of the six-month rates of change considered for the monthly time series (as suggested by Leamer). It was found that the nine-month rates of change generally deliver more stable results in the case of BER survey data[7].

Following a process of evaluation and elimination[8], the following time series performed the best in tracking the SARB-determined business cycle turning points and are suggested to be applied in a recession-dating algorithm for the SA economy:

- RMB/BER business confidence index (5-month moving average; 9-month rate of change);
- Manufacturing physical volume of production (StatsSA/SARB; 5-month moving average)
- Manufacturing capacity utilization (StatsSA/SARB);
- Manufacturing working hours (BER; 5-month moving average; 9-month rate of change)
- Wholesale sales volumes (StatsSA/SARB; 5-month moving average)

As noted above, it is important to distinguish the spurious fluctuations in these economic time series from the underlying business cycle development in order to identify the <u>true</u> upper and lower turning point signals. To this end, a set of *censoring rules* has to be applied in order to eliminate these 'other fluctuations' in the economic time series under investigation (see Boshoff, 2005: 697).

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6 Seasonally adjusted time series were considered. The BER time series data is qualitative in nature and refer to year-on-year comparisons ('net balance statistics'); research has shown that seasonal elements are generally absent in the BER survey data.

7 The BER business opinion survey data is qualitative data, i.e. so-called 'soft data' as opposed to 'hard'/ quantitative statistics. The qualitative data is captured in "net balance statistics" and refer to year-on-year comparisons (% of respondents responding 'up' minus % of respondents responding 'down'). Since these qualitative series are only used in levels, their inclusion presents no difficulties for the proposed algorithm. First and second order derivatives of these series are only used to locate potential turning points in the levels of the series.

8 A whole range of indicators were investigated. Some were discarded without being included in the analysis due to a poor performance (e.g. the real ABSA house price index and the ALSI); others were included in the analysis; however, it was felt that these did not qualify to be included in the algorithm – *see the table in Appendix 2.*

Censoring and other logical business cycle rules

Referring to the discussion of the theoretical issues in relation to business cycle analysis above, it was pointed out that Burns and Mitchell (1946) emphasized that duration of both the (peak-to-trough or trough-to-peak) *phases of the business cycle* and the *total (peak-to-peak or trough-to-trough) business cycle* is a primary characteristic by which to identify the underlying business cycle development (see Boshoff, 2005: 697 and Du Plessis, 2006: 3-4). In line with Boshoff (2005), the following censoring rules were therefore applied in the current study:

- Complete cycles with total duration shorter than fifteen months were eliminated.
- Business cycle phases shorter than six months were eliminated.

Apart from the censoring rules applied to take care of spurious fluctuations in specific economic time series, a particular phase of the business cycle should be a general affair for it to be considered as such. Therefore, once a potential turning point has been established, the following logical business cycle rules are to be applied before an official call can be made regarding a business cycle turning point:

- If in any particular economic time series, the phase of the business cycle or the complete business cycle comply with the first two censoring rules above, the suggested turning point also has to cluster with three or four other indicators in order to be classified as a general turning point; otherwise eliminate.
- If a peak (trough) turning point signal follows on a properly defined peak (trough), it can be ignored as a spurious fluctuation in the time series rather than reflecting an actual business cycle turning point.

Following the methodology outlined above, these general business cycle considerations and the two censoring rules were applied in the analysis of the five selected economic time series in order to derive a new recession-dating algorithm for South Africa.

Investigating a recession-dating algorithm for the SA economy

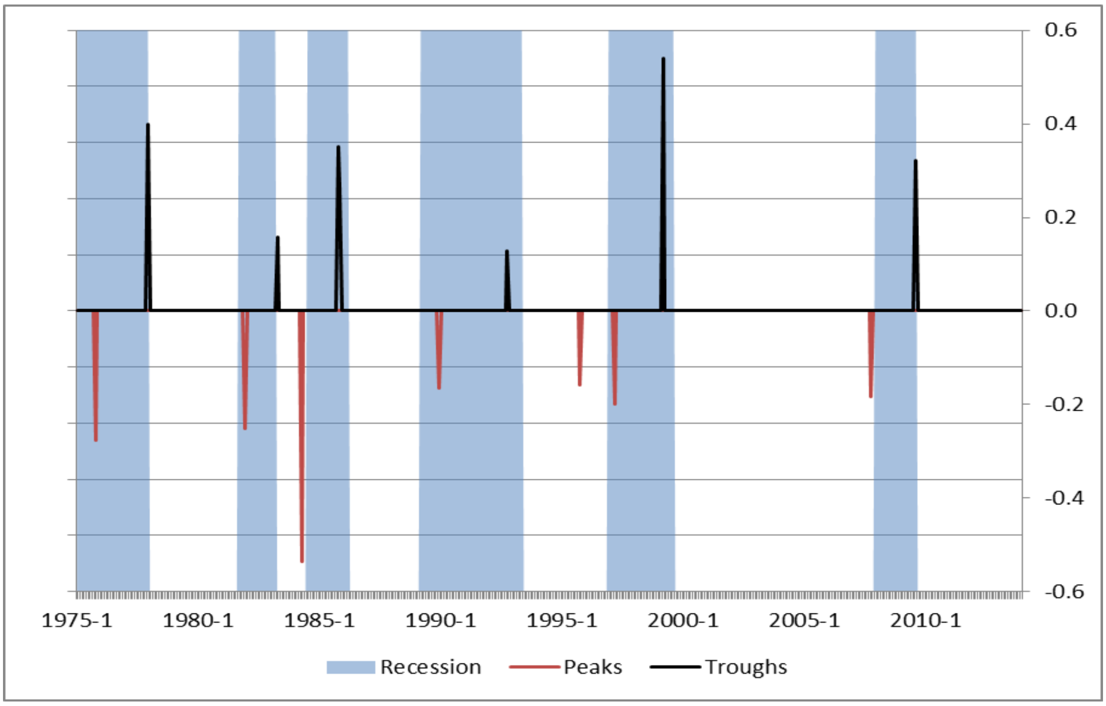
In the section below, the performance of the selected economic indicators is briefly discussed. The charts containing the complete evolution of the respective time series over the 1975 to 2013 period in relation to the SARB-determined business cycle periods are provided in *Appendix 1*. In respect of all five economic time series the general up and down movement of each indicator corresponds to the general business cycle upturns and downturns identified by the SARB. There are deviations though, where an economic indicator may, for instance, contract while the general economy continues to expand (or *vice versa*).

The charts indicating the respective peaks and troughs in the five selected economic indicators are shown and discussed below. Peaks and troughs are indicated in the time series when the second derivative is maximally negative (positive) in the event of a peak (trough). In the charts below upper turning points are indicated by the red arrows (pointing to the bottom of the graph) and lower turning points by the black arrows (pointing to the top of the graph). Also note that the turning point signals shown are those after the application of the censoring rules and before the test of generality. As a result some indicators show (spurious) upturns during recessions and/or downturns during upswing phases of the general business cycle or simply spurious upper or lower turning points. The first indicator considered for inclusion in the algorithm, is the RMB/BER business confidence index produced by the BER in South Africa.

The RMB/BER business confidence index is compiled on the basis of a single question to business executives across five broad economic sectors, namely building & construction, manufacturing, wholesale, retail trade and motor vehicle trade. Respondents to the BER survey have to answer the question: *"Are you satisfied with general business conditions?"* The gross percentage of the respondents (weighted by size) answering in the affirmative then becomes the business confidence index for the particular sector; the overall business confidence index is derived as the arithmetic mean for the five sectors. The index has a proven track record as a reliable business cycle indicator. The quarterly time series is converted to a monthly frequency by assuming the same value for each of the three months of a quarter; the monthly time series is then transformed into a 5-month centered moving average and then the 9-month rate of change is considered in the analysis.

As Figure 1 shows, <u>the RMB/BER business confidence index does an exceptional job in indicating turning points in the SA business cycle</u>. Only in October 1995 the BCI indicates a peak which was not shared by all the other indicators and the SARB's official determination (identifying the business cycle peak in December 1996 – *see the discussion in the next section*). Furthermore, the BCI did not perform well during the 1989-93 recession, lagging the onset of the recession (peak) by 10 months, whilst leading the trough by 7 months. However, this prolonged recession was known for the impact of highly unstable socio-political conditions in SA as well as a protracted drought in agriculture. Including this recession, the BCI tends to *lag* the officially determined peaks with a median of 4 months, while it *leads* the official lower turning points by three months – *see Table 2*[9].

Figure 1: RMB/BER business confidence index: peaks and troughs

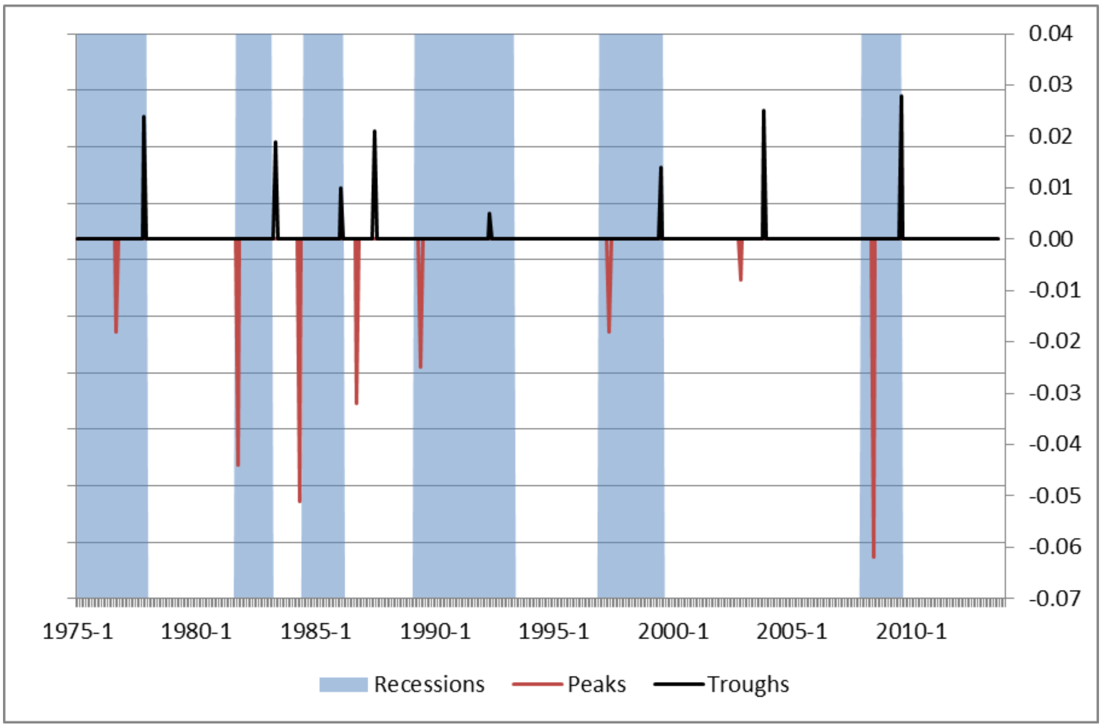


The manufacturing production volume index used in the current analysis is produced monthly by StatsSA, with a one month time lag. The BER also produces a quarterly volume of manufacturing production index, which correlates well with the year-on-year changes in the StatsSA corresponding time series; however, it was decided to use the latter time series as it performed better. It was necessary though to transform the monthly time series into a 5-month centered moving average due to significant volatility in the data; the six-month year-on-year changes in the time series were considered.

As shown by Figure 2, the manufacturing volume of production index performs well in indicating business cycle turning points; however, not as good as the RMB/BER business confidence index. Two spurious downturns are indicated, October 1986 to July 1987 and November 2002 to December 2003, respectively. During both these periods, the manufacturing sector experienced contraction, which

9 It should be noted that these lead and lag times refer to the point in time when the BCI falls through a recession threshold (e.g. by 24% over a 9-month period according to the current analysis) and when the second derivative is maximally negative, i.e. the *'inflection point of the growth momentum'* and not to the numerical peak and trough of the BCI time series.

Figure 2: Manufacturing production volumes (SARB): peaks & troughs



was not shared by the majority of sectors in the economy so as to be classified as a general recession (see Venter, JC: 2005)[10]. Otherwise, the manufacturing production volume index performs well in indicating turning points: the median lag at peaks of the business cycle is 4 months and the lead at the troughs of the business cycle is one month *(see Table 2)*. The index does, however, almost miss the trough of the 89-93 protracted downswing coming in with a lead of 12 months. The index was also slow to pick up the November 1996 and 2007 peaks of the business cycle, lagging it by six and seven months respectively. Whilst the manufacturing production volume index does not perform as well as the BCI, its consistency in indicating all the official peaks and troughs qualify it to be included in the algorithm.

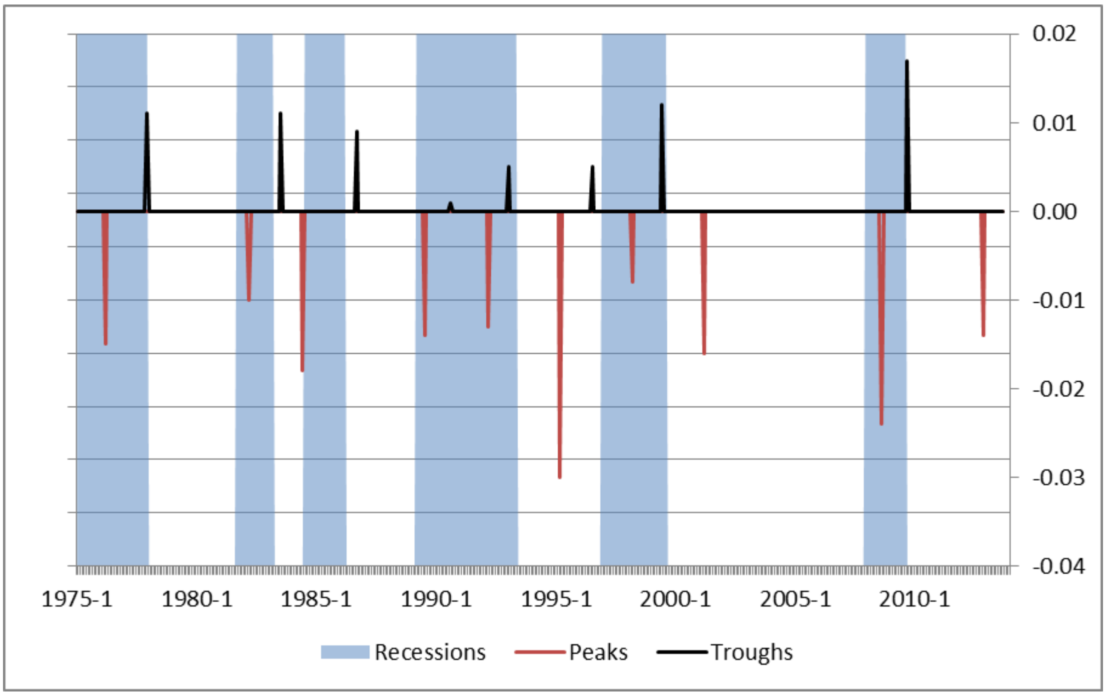
The manufacturing production capacity utilization index is a quarterly index produced by StatsSA with a time lag of three months. For the purposes of the current exercise, the quarterly index was converted to a monthly time series (applying a cubic spline).

As Figure 3 shows, the index signals two spurious business cycle phases – *one*, an upturn between August 1990 and March 1992 and, *second*, a contraction between March 1995 and July 1996. The latter is in line with the other manufacturing indicators, but which did not qualify as a general

[10] The current analysis of the other time series investigated does show recessionary conditions from around the middle of 2002 to end-2003; interest rates were hiked by 400 basis points during the course of 2002 and the rand strengthened dramatically following the end-2001 currency collapse, which impacted adversely on the manufacturing sector. However, again, the recessionary conditions were not shared by all the sectors of the economy (see Appendix 3).

recession *(see the discussion in the following section)*. The manufacturing capacity utilization index also does not perform well during the 1997-99 recession – it lags the onset of the recession with no less than 16 months. The trough of this recession is well indicated, but is then followed by a spurious peak (March 2001). It also lags the onset of the 2007-09 recession by 9 months and signals a spurious peak in November 2012. The manufacturing capacity utilization index performs better in indicating lower turning points than in indicating upper turning points; it tends to lag business cycle peaks by a median 7 months and business cycle troughs by only one month – *see Table 2.* For the purposes of the algorithm, it may be prudent to only consider this indicator's trough signals.

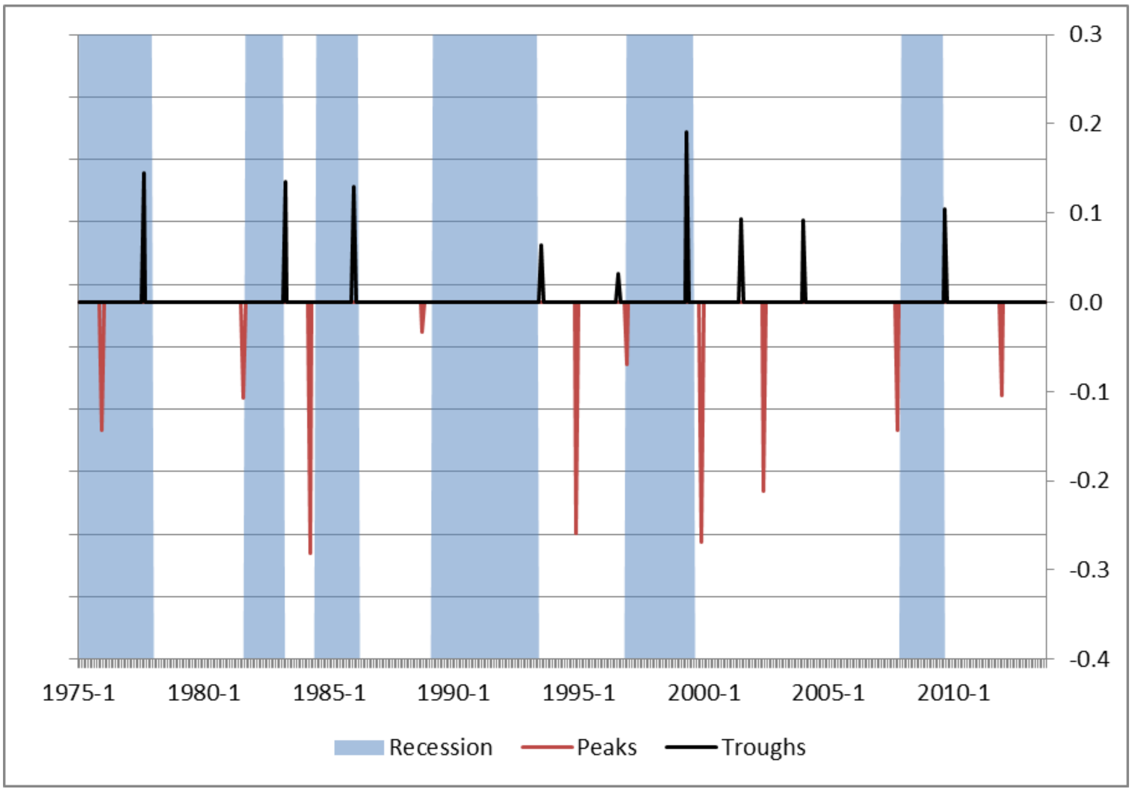
Figure 3: Manufacturing production capacity utilization: peaks & troughs



Manufacturing working hours are gauged in the BER manufacturing survey; the quarterly net balance statistic is converted to monthly data and then a 5-month centered moving average is calculated. Furthermore, the 9-month rate of change in this statistic is considered for the purposes of the current analysis.

As Figure 4 shows, the manufacturing working hours statistic turns out to be an excellent coinciding indicator; however, there were some spurious signals. *Firstly*, a peak formed at the end of 1994 during the 1993-96 economic upswing; the indicator troughed again during August 1996, just before the end of the upswing (December 1996). As noted, this (mini) downswing is indicated by some of the other indicators investigated in the current study as well – *see Table 2 and the discussion, page 16* – but was not regarded as a general recession. The *second* and *third* instances during which the indicator registered a decline, was from end-1999 to mid-2001 and mid-2002 to end-2003, both during the initial phase of SA's record 1999-07 economic expansion where manufacturing working hours oscillated sharply during a period of extreme exchange rate volatility. In both instances, the contraction in manufacturing working hours was not shared by all economic sectors. The working hours net balance statistic also signaled an upper turning point in December 2011 (similar to the manufacturing capacity utilization index) reflecting recessionary conditions in manufacturing not being shared by the other sectors of the economy.

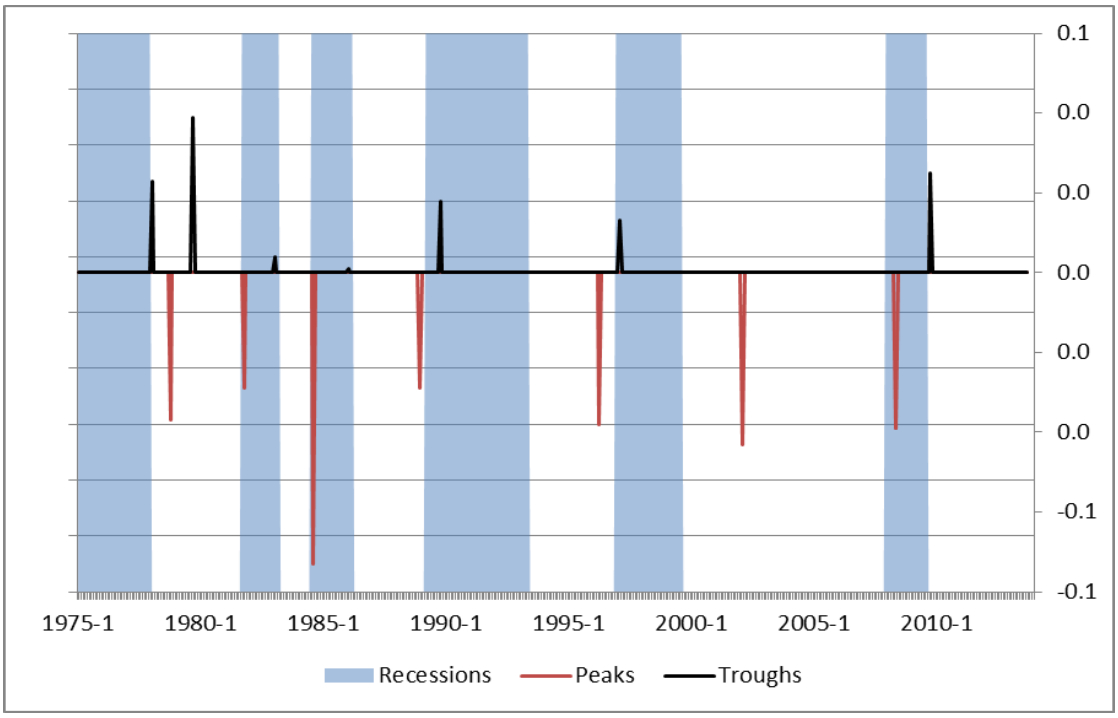
Figure 4: Manufacturing working hours: peaks and troughs



Whilst the performance of this index is not as clean as that of the RMB/BER BCI, it does an exceptional job in terms of coinciding with the official SARB determined business cycle turning points – in respect of all the cycles over the 1975 to 2013 period. The median lead at both cycle peaks and at cycle troughs is one month – *see Table 2*. While care need to be applied when movements in this indicator are evaluated, its consistency in indicating business cycle turning points qualify it for inclusion in the recession-dating algorithm.

The wholesale volume index is produced by StatsSA and also published by the SARB on a monthly basis. While the BER also surveys the wholesale sector, the survey data did not perform that well in the analysis. When a 5-month centered moving average of the (SARB) wholesale index was used, the results improved, albeit evident that the wholesale index is a volatile indicator.

Figure 5: Wholesale sales volumes: peaks and troughs



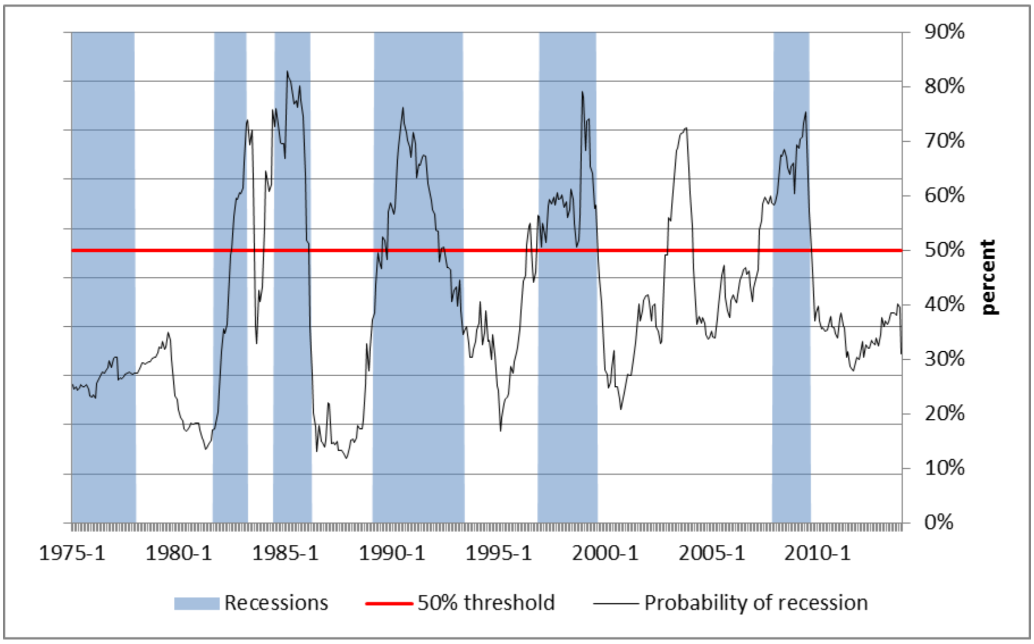
The wholesale volume index indicates an economic downturn between October 1978 and September 1979, which ran counter to the general direction of the economy. Interestingly, soon after the onset of both the 1989-93 and 1997-99 recessions, the index also showed two trough signals, i.e. October 1989 and February 1997 respectively, which came well before the actual lower turning points. Finally, the index also showed a spurious peak signal in February 2002 during the initial phase of the 1999-07 record economic expansion. As all these signals did not cluster with other indicator turning points they could be discarded as spurious. Nonetheless, Figure 5 shows that the wholesale volume index does succeed in indicating most of the official turning points; it only misses the end of the 1989-93 and 1997-99 recessions and leads the onset of the latter recession by (a relatively long) seven months. Its median lag time at business cycle peaks is two months and it has a one month lead time for business cycle troughs. Given this degree of accuracy, it was decided to include the wholesale index in the algorithm; however, its use for dating recessions has to be handled with circumspection and in conjunction with other time series. <u>This index may be particularly useful in *confirming* – as opposed to – in *determining* business cycle turning points</u>.

The above section considered the results for each time series and briefly discussed the basis for their inclusion in the algorithm. This section now proceeds to also consider the yield differential (between 10-year and 3-month government bonds), i.e. a proven business cycle indicator, as a possible first step in the algorithm. In the section that follows, the results are integrated in order to derive a recession-dating algorithm for South Africa.

The yield spread

One indicator not mentioned above, is the yield differential between the 10-year government bond and 3-month Treasury bill, which has been shown to be a reliable and leading business cycle indicator (see Moolman, 2003). Given its proven track record as a predictor of business cycle turning points it was decided to include this indicator in the recession-dating algorithm. As the yield spread tends to have a consistent 6-month lead, the series proposed for the algorithm is one brought forward by six months – *see Figure 6*[11]*.*

Figure 6: Yield spread as a predictor of business cycle turning points*



* *Based on the yield spread between a 10-year & 3-month government bond yield brought forward by 6 months*

The performance of the indicator improves towards the end of the 1990s and during the 2000s, with it being spot on in predicting the lower turning points of both the 1997-99 and 2007-09 economic downswings; it led the March 1986 trough by one month and the November 1996 peak by one month. The other turning points, particularly over the 1980s/ early 1990s were predicted (or confirmed) with less accuracy *(see Table 2)*. The median lead time over all the cycles included in the analysis is quite impressive, being one month at business cycle peaks and zero at troughs.

It is therefore suggested that signals given by the yield spread (6 months in advance) be considered as a first step in the algorithm.

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11 The time series shown in the chart is the *'probability of recession'* calculated from the yield spread using a logit model.

A recession-dating algorithm for SA

Table 2 contains a summary of the business cycle turning point signals provided by all the time series selected for the purposes of the recession-dating algorithm. The bottom of the table contains a number of spurious turning point signals (or recessions) detected by the methodology applied in the current paper. Not shown in the table or the charts, are a number of other spurious peak and trough signals tied to fluctuations in the relevant economic time series not necessarily related to the underlying business cycle development. Applying the censoring rules to the various spurious turning point signals was a relatively straightforward affair and resulted in the elimination of most. However, two periods stand out, where a number of indicators in each case pointed to a possible recession, albeit not classified as such due to a lack of generality.

- *Firstly*, a number of upper and lower turning points are clustered over the period end-1994 to mid-1996, i.e. the 24 month period running up to the official business cycle peak in November 1996. The yield spread indicates a brief recession April to July 1996; the BCI peaks in October 1995; the manufacturing hours index peaks December 1994 and troughs August 1996; and the manufacturing capacity utilization index peaks March 1995 and troughs July 1996. However, closer inspection reveals that at no time over the full length of this period were more than three indicators beyond their recession thresholds; manufacturing production volume in particular remained in expansion mode throughout *(see Appendix 3)*. While the full peak-to-trough phases in manufacturing hours and capacity utilization are both longer than the six month censoring rule requirement, these downturns are not shared by the other indicators. Only the yield spread points to a brief downturn from April to July 1996, but this does not comply with the censoring rule. It follows that these recession signals can be discarded; strict adherence to the recession dating algorithm would most likely have resulted in such a dating outcome.

- *Secondly*, another clustering of turning point signals occurs over the period mid-2002 to early-2004 (i.e. in the wake of a 400 basis point increase in interest rates to counter the inflationary impulse from excessive exchange rate volatility experienced in 2001/2). The yield spread indicates a proper recession from December 2002 to February 2004; the manufacturing production index indicates a downturn from November 2002 to November 2003 and the manufacturing hours index a downturn from June 2002 to January 2004. In the end, this recession was classified as partial, i.e. not a general affair (the non-tradable goods sectors were, for instance, not in recession; see Venter JC, 2005: 62). In this case, adherence to the algorithm would again have prevented an erroneous call as the wholesale index, the BCI and even the manufacturing capacity utilization index did not show a recession during this whole period.

Therefore, evaluating whether the proposed algorithm would have led to a Type II error (i.e. suggesting the economy was in recession while it was not) it is found to be unlikely. In fact, Type II errors regarding both these periods are likely to have been avoided – *see Appendix 3*.

A *third period* where the algorithm is presented with a challenge, regards the 1997-99 recession peak *(see Appendix 3).* While all the indicators signaled a peak (with various leads and lags), it is only the yield spread that clearly resides in recession territory (i.e. with the probability of recession above 50%); the other indicators signaled a peak, however, without moving beyond their recessionary thresholds, except the BCI and the manufacturing production index which do so towards the end of 1997. This recession was a so-called *growth recession* (i.e. only a relative contraction in the economic growth momentum) as opposed to a *classical recession* (with an absolute contraction in economic activity, as measured by GDP). The wholesale index, for instance, hardly moved beyond its recessionary threshold during the 1997-99 recession (only for brief period towards the end of 1996) despite giving an advance peak signal. This hints towards a possible tweak required in the recession-dating algorithm in order to make provision for indicator behavior during growth recessions – see Du Plessis (2006: 4-5)[12]. *Some additional remarks are in order regarding Table 2 below:*

- It is quite evident that almost all the indicators performed relatively poorly in indicating the upper and lower turning points of the 1989-93 recession. This recession was marred by political instability and prolonged by a serious drought in agriculture, which can assist in explaining this indicator behaviour.

- Whereas the 1989-93 recession is indicated poorly, the opposite applies in the case of the latest (i.e. the 2007-09) recession, which was indicated accurately by almost all the indicators, particularly the August 2009 trough. This is presumably explained by the precipitous fall in economic activity during the global financial crisis (i.e. a clean and transparent contraction in economic activity) and the subsequent relatively swift (albeit constrained) economic recovery.

The general performance of the selected time series is only moderately less optimal compared with that of the Leamer exercise in respect of the US economy (see Leamer, August 2008: 23). While the overall median lead and lag times in respect of the identified recessions (two months) compares well

[12] The technique involved would require a 'de-trending' of the selected time series and then applying the algorithm. This is an area for future research.

Table 2: Business cycle turning points – selected time series for recession-dating algorithm

			STEP 1		Indicators for consideration in STEP 2-4										STEP 5	
		SARB	**Yield spread (10y-3m)***	**Dif**	**BCI BER**	**Dif**	**Mnf prod SARB** 5mma	**Dif**	**Mnf hours BER**	**Dif**	**Mnf cap util SSA**	**Dif**	**Wsale sales SSA** 5mma	**Dif**	**Median#**	**Dif**
1	Peak	**8/74**	-	-	-	-	-	-	-	-	-	-	-	-	**-**	**-**
	Trough	**12/77**	-	-	12/77	0	11/77	-1	8/77	-4	12/77	0	1/78	+1	**12/77**	**0**
2	Peak	**8/81**	6/82	+10	12/81	+4	10/81	+2	8/81	0	3/82	+7	10/81	+2	**10/81**	**+2**
	Trough	**3/83**	7/83	+4	4/83	+1	5/83	+2	4/83	+1	7/83	+4	1/83	-2	**4/83**	**+1**
3	Peak	**6/84**	12/83	-6	4/84	-2	5/84	-1	4/84	-2	6/84	0	8/84	+2	**4/84**	**-2**
	Trough	**3/86**	2/86	-1	10/85	-5	2/86	-1	1/86	-2	9/86	+6	1/86	-2	**1/86**	**-2**
4	Peak	**2/89**	7/89	+5	12/89	+10	6/89	+4	10/88	-4	7/89	+5	12/88	-2	**3/89**	**+1**
	Trough	**5/93**	6/92	-11	10/92	-7	5/92	-12	7/93	+2	1/93	-4	-	-	**11/92**	**-6**
5	Peak	**11/96**	10/96	-1	3/97	+4	5/97	+6	12/96	+1	3/98	+16	4/96	-7	**2/97**	**+3**
	Trough	**8/99**	8/99	0	3/99	-5	7/99	-1	5/99	-3	6/99	-2	-	-	**5/99**	**-3**
6	Peak	**11/07**	3/07	-8	10/07	-1	6/08	+7	10/07	-1	8/08	+9	5/08	+6	**2/08**	**+3**
	Trough	**8/09**	8/09	0	8/09	0	8/09	0	9/09	+1	9/09	+1	10/09	+2	**9/09**	**+1**
Med	Peak			-1.0		+4.0		+4.0		-1.0		+7.0		+2.0		**+2**
	Trough			0.0		-3.0		-1.0		-1.0		+1.0		-1.0		**-1**

Additional cycles

	SARB	Yield spread	BCI BER	Mnf prod SARB	Mnf hours BER	Mnf cap util SSA	Wsale sales SSA	Median
Peak		12/02	10/95	10/86	12/94	-	10/78	
Trough		2/04	-	7/87	8/96	8/90	9/79	
Peak				11/02	12/99	3/92	-	
Trough				11/03	7/01	-	10/89	
Peak					6/02	3/95	-	
Trough					1/04	7/96	2/97	
Peak					12/11	3/01	2/02	
Trough					-	-	-	
Peak						11/12		
Trough						-		
Peak								
Trough								

** Yield difference between 10y govt bond and 3m TB, brought forward 6 months*

 # Median peaks calculated from BCI; mnf prod; mnf hours & wsale, i.e. excluding mnf cap util. Median troughs are calculated from all five indicators.

with the results of the Leamer exercise (zero months) and other similar studies[13], the current study found significantly more volatility, reflected in the number of spurious signals. As discussed above, the manufacturing production volume index, manufacturing capacity utilization, manufacturing working hours and wholesale sales indices all provide a number of spurious business cycle phases, peaks and troughs *(see the bottom of Table 2)*. Business cycle research studies have found that economic fluctuations in developing economies tend to be more volatile compared to that of advanced economies – see Du Plessis (2006: 3).

While there appears to be room for error in the current model, *the overall results are satisfactory as all the spurious signals could be discarded either through the application of the censoring rules and/or the important consideration of generality*. Furthermore, it is suggested that the manufacturing capacity utilization indicator only be used for trough signals and the wholesale sales index only to confirm a business cycle turning point suggested by the other indicators. The proposed algorithm is stated below.

The proposed recession-dating algorithm:

- STEP 1. A probable recession (i.e. a peak in the business cycle) is indicated as soon as the 6-month advanced 'probability of recession' (calculated from the yield spread) exceeds the 50 threshold. The end of the recession is indicated when this indicator moves below the critical level of 50 again.

- STEP 2. Determine a probable recession based on the following five thresholds:
  a. A decline in the (5-month centered moving average) RMB/BER business confidence index over 9 months at a rate of 24% or more
  b. A decline in the (5-month centered moving average) manufacturing production volume index over 6 months at a rate of 1.2% or more
  c. A decline in the manufacturing capacity utilization index over 6 months at a rate of 1.4% or more
  d. A decline in the (5-month centered moving average) manufacturing hours worked index (BER survey) over 9 months at a rate of 6.7% or more
  e. A decline in the (5-month centered moving average) wholesale sales volume index over 6 months by 2.3% or more

[13] The overall median lag time for peaks in the current study is one month and the lead time for troughs is also one month, which compares well with other studies, such as that of Harding & Pagan (2006) in respect of the US economy.

- STEP 3. Determine if the latest reading of each of the time series in step 2 gives a peak (or a trough) signal, i.e. when the second derivative is maximally negative (positive); regarding the manufacturing capacity utilization time series, only consider trough signals.

- STEP 4. This is a two-stage process:
    a. Determine a potential turning point by reconciling the differences in the peak and trough dates suggested in STEP 3 by using the median of three dates (in the case of business cycle peaks; i.e. business confidence, manufacturing production and manufacturing hours) and four dates (in the case of business cycle troughs; i.e. the former-mentioned three, as well as manufacturing capacity utilization).
    b. Consider the signal given by the wholesale volume index; if it agrees with the median turning point determined in STEP 4a, this will confirm the turning point; if not, one should gather more data in order to confirm and call a turning point.

Table 3: Performance of the recession-dating algorithm

Recession			SARB	Median turning point – algorithm	Lead(-) / Lag(+)	Announce lag* (months)	Lead SARB# (months)
1.	**'81-83**	Peak	8/81	10/81	+2	8	-2
		Trough	3/83	4/83	+1	7	?
2.	**'84-86**	Peak	6/84	4/84	-2	5	?
		Trough	3/86	1/86	-2	9	?
3.	**'89-93**	Peak	2/89	3/89	+1	10	?
		Trough	5/93	11/92	-6	4	-21
4.	**'97-99**	Peak	11/96	2/97	+3	8	-23
		Trough	8/99	5/99	-3	1	-20
5.	**'07-09**	Peak	11/07	2/08	+3	10	-4
		Trough	8/09	9/09	+1	5	-17
Median		**Peak**			**+2**	**8.2**	-
		Trough			**-1**	**5.2**	-

** Number of months from the actual turning point to the BER announcement date.*

 # Number of months between the BER and SARB announcement dates.

The performance of the algorithm was tested against the historical officially determined business cycle turning points, i.e. for the five recessions over the period 1981Q3 to 2013Q4. The results are contained in Table 3. It is found that the algorithm will allow the BER to make more timeous calls on business cycle turning points with a reasonably high degree of accuracy – *over the period under consideration, the median lag at official business cycle peaks was two months and the lead at business cycle troughs one month*. Furthermore, considering the timing of the relevant data releases, it should be possible to announce such a turning point with a significant shorter time lag after the event compared to the SARB's extensive dating decision. In terms of the five recessions considered in the current study, *the median announcement lag for peak signals is eight months and for trough signals five months*; this implies an average lead of the SARB decision of 10 months and 19 months respectively – *see Table 3*.

Concluding remarks

The objective of the current research was to establish whether it was possible to design a recession-dating algorithm, which could allow the BER to make accurate calls on business cycle turning points substantially sooner after the event than is the case with the official SARB determination, which typically lags actual turning points by 18 to 24 months (and longer).

The proposed algorithm includes, as a point of departure, the advance signals given by the yield spread (between 3-month and 10-year government bonds), as well as a consideration of the local moments of five high-frequency economic time series, namely the RMB/BER business confidence index, manufacturing physical production volumes, manufacturing production capacity utilization, manufacturing working hours and wholesale sales volumes. The turning point signals provided by these indicators (after application of censoring rules) are integrated by reconciling the differences through the use of the median date in order to derive business cycle turning point signals.

Testing the algorithm for the five recessions experienced between 1981 and 2013 the results were most satisfactory. *Firstly*, while the data tends to be volatile, all the spurious signals could be discarded on the basis of the censoring rules and/or the generality requirement, i.e. both Type I and Type II errors in the calling of business cycle turning points were likely to have been avoided over this 32-year period. *Secondly*, a high degree of accuracy was obtained, <u>i.e. a median two month lag at upper business cycle turning points and a one month lead at troughs</u>. *Finally*, the algorithm will not only allow the BER to make close calls on business cycle turning points, it will be able to do this with a much shorter time delay (10 to 19 months sooner) compared to the SARB's official determination.

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March 2014

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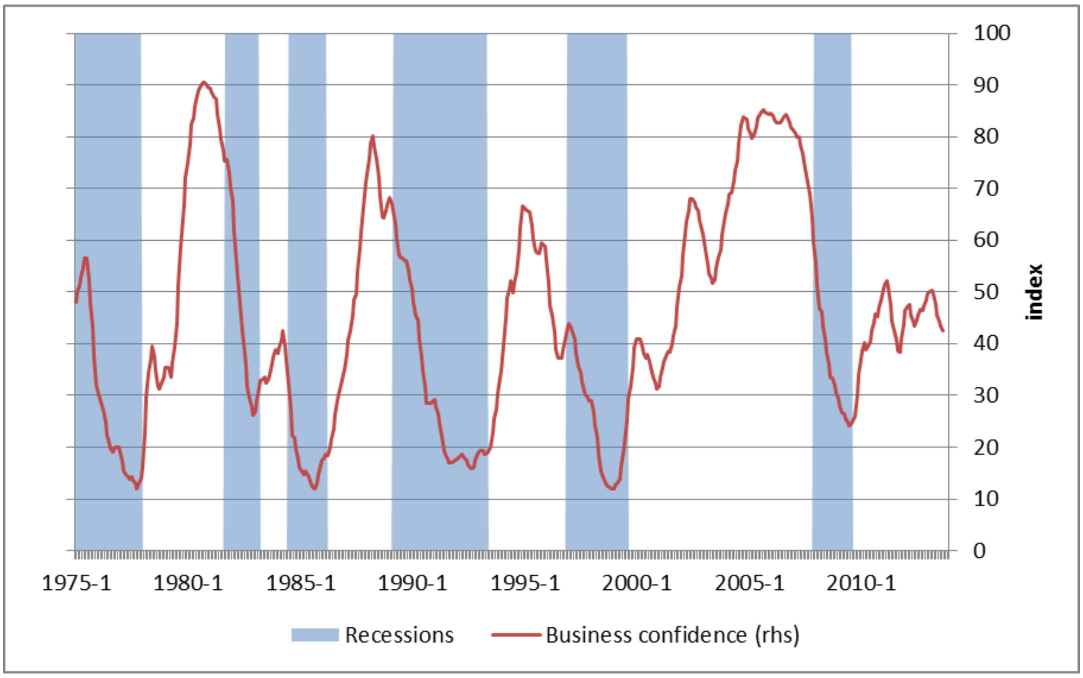
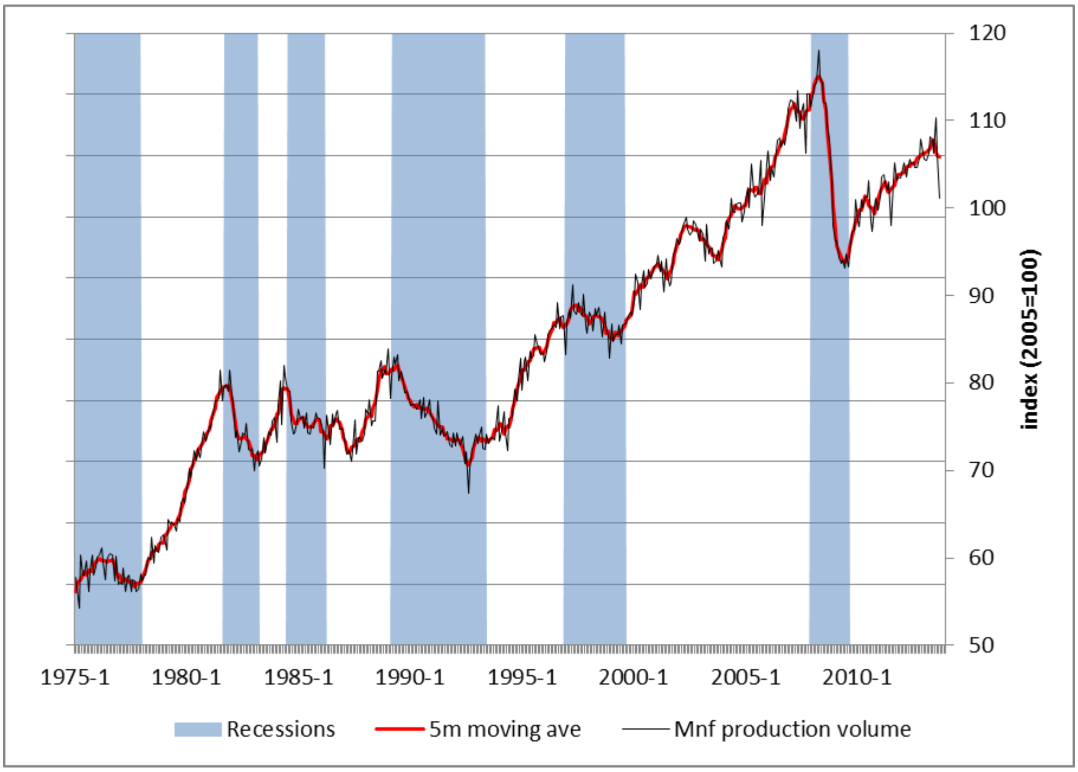
Appendix 1: The evolution of five economic time series in relation to the SA business cycle[14]

Figure 7: RMB/BER Business confidence index across business cycles



Source: BER

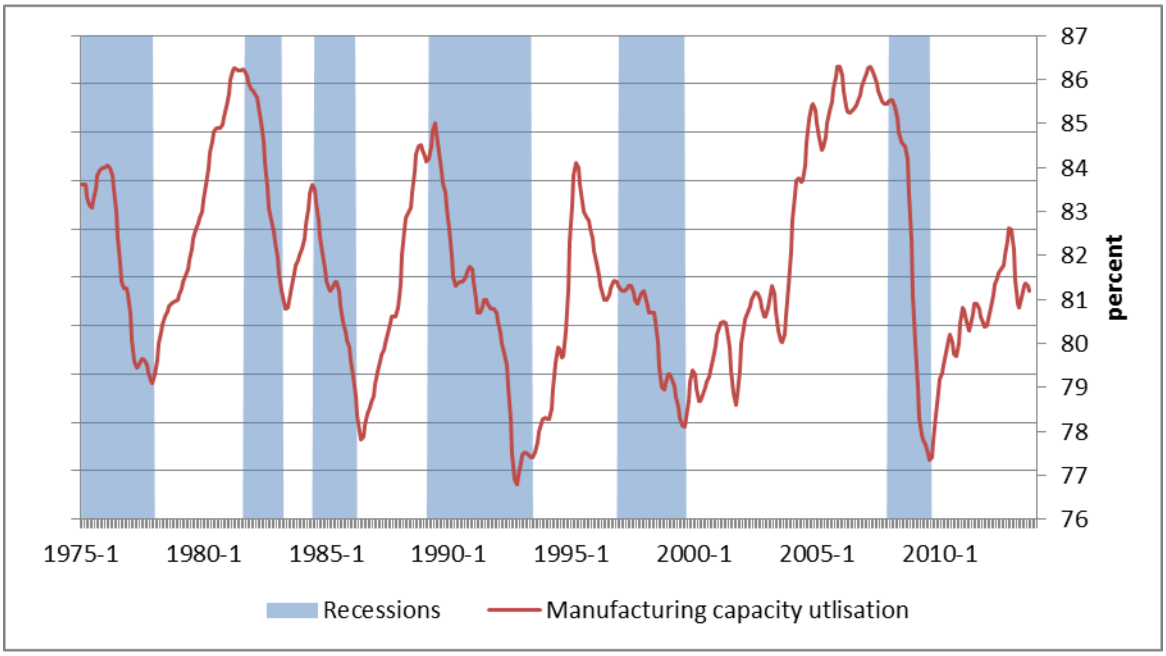
Figure 8: Manufacturing production volume index (StatsSA) across business cycles



Source: StatsSA/ SA Reserve Bank

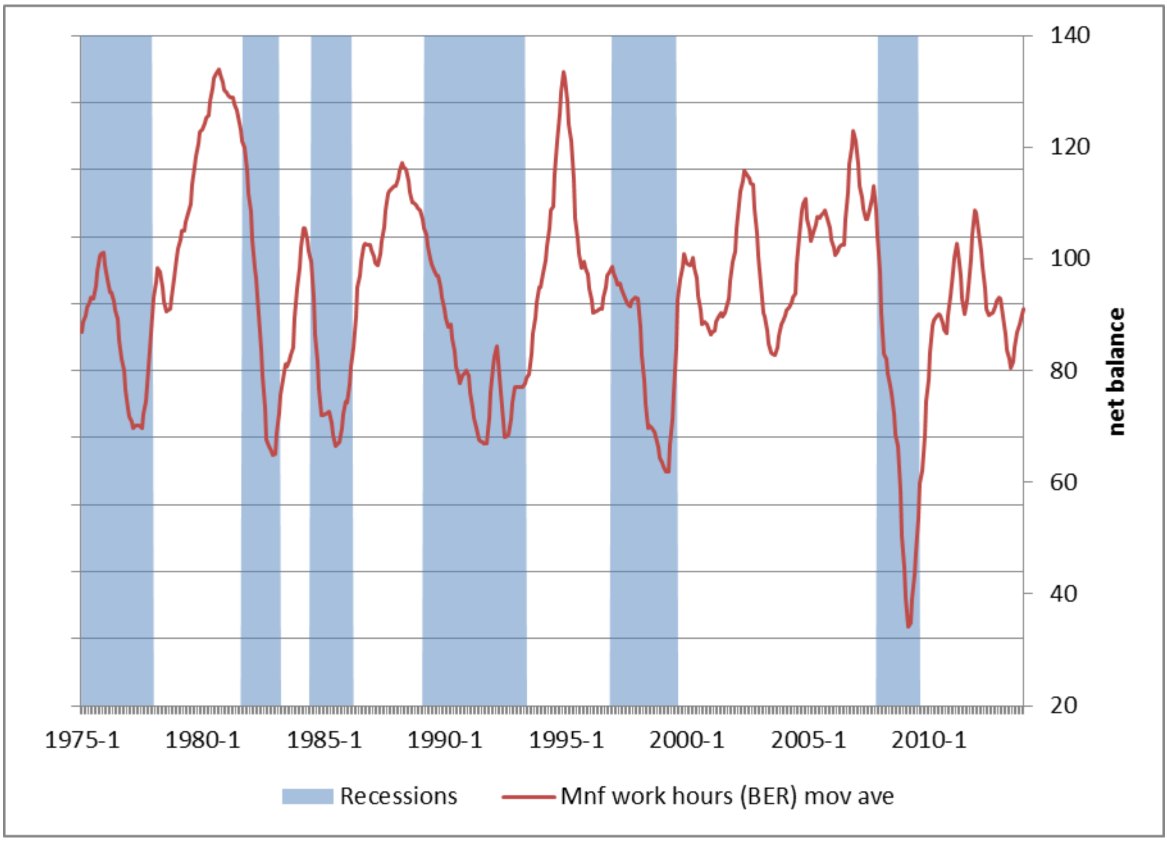
[14] The shaded areas in the charts correspond to the peak+1 to trough period, i.e. it does not include the month during which the peak was registered as that month is part of the expansion.

Figure 9: Manufacturing capacity utilization across business cycles



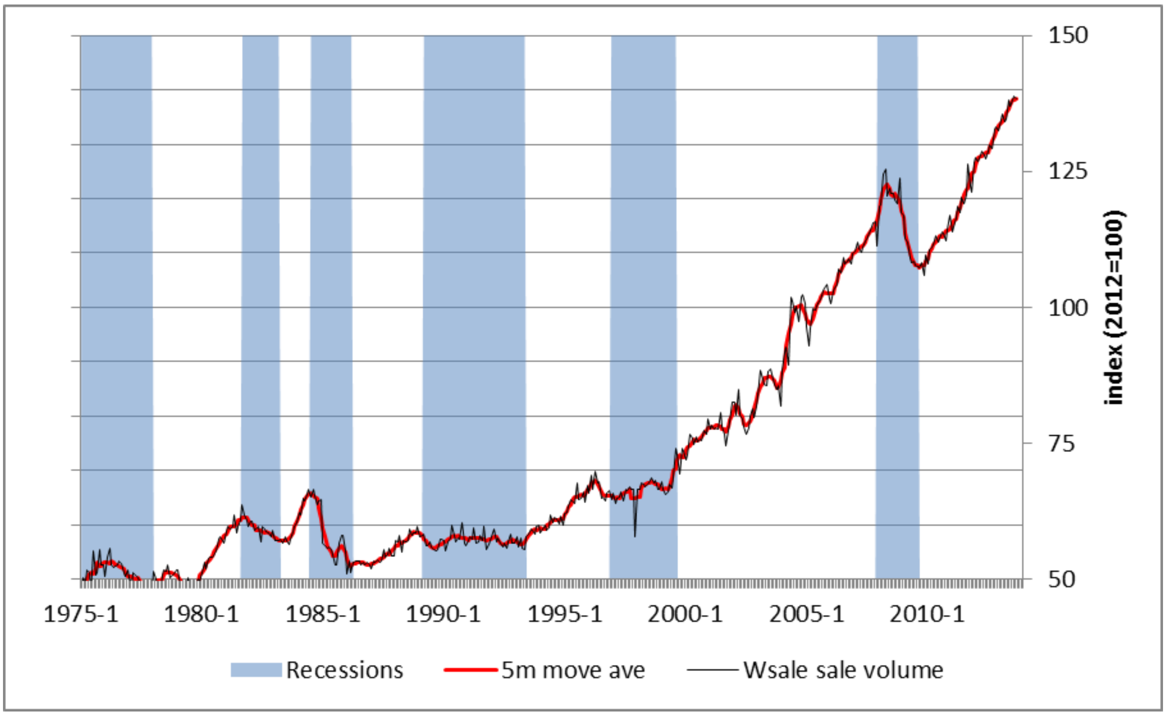
Source: StatsSA/ SA Reserve Bank

Figure 10: Manufacturing working hours across business cycles



Source: BER

Figure 11: Wholesale sales volumes across business cycles



Source: StatsSA/ SA Reserve Bank

Appendix 2: Business cycle turning points – an analysis of selected series: 1975 to 2013

		SARB	Mnf prod BER 5mma	Dif	Mnf orders BER	Dif	Retail sales SSA 5mma	Dif	Non-agric employ ment	Dif	Trade sales vol SSA	Dif	Retail sales BER	Dif	CCI BER	Dif
1	Peak	**8/74**									-		-	-	-	-
	Trough	**12/77**	7/77	-5	11/76	-13	-	-	3/78	+3	7/79	+19	-	-	-	-
2	Peak	**8/81**	1/82	+5	10/81	+2	-	-	5/82	+9	12/81	+4	-	-	-	-
	Trough	**3/83**	2/83	-1	11/82	-4	-	-	4/83	+1	2/83	-1	-	-	-	-
3	Peak	**6/84**	5/84	-1	1/84	-5	4/84	-2	8/84	+2	4/84	-2	-	-	6/84	0
	Trough	**3/86**	8/85	-7	6/85	-9	12/86	+9	8/85	-7	1/87	+10	-	-	12/85	-3
4	Peak	**2/89**	1/90	+11	4/90	+14	8/90	+13	4/90	+14	7/90	+17	6/89	+4	10/89	+8
	Trough	**5/93**	-	-	4/93	-1	4/93	-1	-	-	3/93	-2	4/94	+11	5/93	0
5	Peak	**11/96**	12/97	+13	10/97	+11	11/97	+12	10/96	-1	9/96	-2	1/96	-10	10/97	+11
	Trough	**8/99**	2/99	-6	2/99	-6	11/98	-9	-	-	4/99	-4	6/99	-2	6/99	-2
6	Peak	**11/07**	9/07	-2	10/07	-1	1/09	+14	11/08	+12	5/08	+6	7/07	-4	12/07	+1
	Trough	**8/09**	6/09	-3	8/09	0	10/09	+2	-	-	9/09	+1	8/09	0	10/08	0
Med	Peak			+4.0		+1.0		+12.0		+8.0		+3.0		+3.0		+3.5
	Trough			-5.0		-6.0		0		-		-0.5		-1.0		-1.0

Additional cycles

Peak		7/95	9/95		4/01	1/02	10/00	2/88
Trough		6/96	7/96		3/02	1/03	10/01	6/89
Peak		10/02	10/02		12/02			12/99
Trough		10/03	9/03		11/03			12/00
Peak								4/02
Trough								7/03

Appendix 3: Three periods – testing the algorithm

Table 4: Evaluating the period end-1994 to mid-1996

	Threshold					
Period end-1994 to mid-1996	0.5 Yield spread**	-24% BCI	-1.20% Mnf prod	-1.40% Mnf capacity	-6.70% Mnf hours	-2.30% Whole-sale
1994-6	0.388	103.9	0.3	2.0	25.4	2.1
1994-7	0.334	81.8	0.7	2.0	22.4	2.3
1994-8	0.334	70.4	2.4	1.8	24.9	2.8
1994-9	0.299	61.1	5.0	1.5	27.4	2.9
1994-10	0.346	68.2	6.1	1.6	32.6	1.7
1994-11	0.307	56.8	6.4	2.1	33.3	1.5
1994-12	0.252	48.0	7.4	3.0	33.9	1.4
1995-1	0.245	35.5	7.3	4.1	29.5	1.7
1995-2	0.168	30.4	5.8	5.2	21.6	2.5
1995-3	0.194	25.7	4.8	5.5	14.2	3.9
1995-4	0.219	31.3	3.9	4.6	10.6	4.6
1995-5	0.228	21.2	3.3	3.0	-0.9	6.2
1995-6	0.232	11.9	3.2	1.1	-11.2	6.2
1995-7	0.237	-0.7	2.9	-0.2	-17.8	5.2
1995-8	0.287	-7.7	2.9	-1.1	-22.2	4.8
1995-9	0.276	-13.8	2.9	-1.5	-26.3	3.4
1995-10	0.296	-10.2	2.1	-1.6	-24.8	2.6
1995-11	0.312	-10.3	1.1	-1.5	-23.2	1.3
1995-12	0.323	-10.4	0.3	-1.3	-21.6	2.2
1996-1	0.355	-14.1	-0.3	-1.4	-21.7	2.3
1996-2	0.390	-17.5	0.4	-1.6	-18.9	3.4
1996-3	0.444	-21.3	0.9	-1.8	-15.8	3.5
1996-4	0.454	-21.1	1.9	-1.8	-12.5	4.3
1996-5	0.509	-26.7	3.2	-1.7	-10.1	2.6
1996-6	0.542	-32.4	4.3	-1.3	-7.5	0.9
1996-7	0.550	-37.6	3.9	-0.9	-8.6	-0.9
1996-8	0.471	-37.2	3.5	-0.4	-5.5	-3.1
1996-9	0.441	-36.7	3.1	0.1	-2.3	-3.7
1996-10	0.460	-31.0	1.3	0.4	2.3	-4.4
1996-11	0.563	-20.8	0.2	0.5	5.6	-3.0
1996-12	0.562	-8.9	-0.2	0.4	9.1	-2.7

Notes:

1997-1	SARB recession
	Probable recession
25.2	Peak signal
-10.4	Trough signal

** Probability of recession

Table 5: Evaluating the recessionary period mid-2002 to early-2004

	Threshold					
Period mid-2002 to early-2004	0.5 Yield spread**	-24% BCI	-1.20% Mnf prod	-1.40% Mnf capacity	-6.70% Mnf hours	-2.30% Whole-sale
2002-6	0.361	63.5	2.2	1.4	27.0	-2.3
2002-7	0.351	56.7	1.6	1.0	24.1	-4.2
2002-8	0.329	42.4	0.7	0.7	18.9	-4.0
2002-9	0.333	30.2	0.2	0.4	14.1	-2.9
2002-10	0.441	23.8	-0.3	-0.1	11.8	-0.5
2002-11	0.491	11.5	-0.4	-0.5	3.2	1.8
2002-12	0.492	1.0	-0.6	-0.6	-4.7	5.8
2003-1	0.560	-4.1	-1.5	-0.4	-10.5	7.3
2003-2	0.553	-11.6	-1.1	0.0	-16.3	8.3
2003-3	0.583	-18.5	-1.4	0.4	-21.9	8.8
2003-4	0.632	-21.2	-1.7	0.4	-22.2	8.6
2003-5	0.683	-21.7	-2.1	0.2	-23.8	7.0
2003-6	0.687	-22.3	-1.9	-0.4	-25.4	5.1
2003-7	0.711	-20.1	-1.9	-0.9	-26.6	3.7
2003-8	0.714	-14.4	-2.0	-1.4	-23.9	2.1
2003-9	0.715	-8.4	-1.9	-1.4	-20.8	0.5
2003-10	0.722	-4.6	-1.9	-0.6	-16.1	-2.1
2003-11	0.724	4.8	-0.9	0.7	-9.6	-2.0
2003-12	0.648	15.2	-0.1	2.2	-2.4	-0.9
2004-1	0.604	21.6	1.5	3.4	-0.9	0.9
2004-2	0.544	27.4	2.1	4.2	3.0	2.0
2004-3	0.467	33.3	4.0	4.4	7.1	7.3
2004-4	0.400	32.1	5.1	3.9	9.6	11.9
2004-5	0.364	30.8	4.9	2.9	11.1	13.5
2004-6	0.379	29.6	4.6	1.9	12.6	13.7

Notes:

1997-1	SARB recession
	Probable recession
25.2	Peak signal
-10.4	Trough signal

** Probability of recession

Table 6: Evaluating the 1997-99 'growth recession'

	Threshold					
Recession 97-99 peak	0.5 Yield spread**	-24% BCI	-1.20% Mnf prod	-1.40% Mnf capacity	-6.70% Mnf hours	-2.30% Whole-sale
1996-3	0.444	-21.3	0.9	-1.8	-15.8	3.5
1996-4	0.454	-21.1	1.9	-1.8	-12.5	4.3
1996-5	0.509	-26.7	3.2	-1.7	-10.1	2.6
1996-6	0.542	-32.4	4.3	-1.3	-7.5	0.9
1996-7	0.550	-37.6	3.9	-0.9	-8.6	-0.9
1996-8	0.471	-37.2	3.5	-0.4	-5.5	-3.1
1996-9	0.441	-36.7	3.1	0.1	-2.3	-3.7
1996-10	0.460	-31.0	1.3	0.4	2.3	-4.4
1996-11	0.563	-20.8	0.2	0.5	5.6	-3.0
1996-12	0.562	-8.9	-0.2	0.4	9.1	-2.7
1997-1	0.505	-3.9	-0.2	0.2	7.5	-1.3
1997-2	0.549	1.9	0.3	-0.1	6.2	-1.1
1997-3	0.528	8.8	1.2	-0.2	4.8	-0.2
1997-4	0.515	9.7	2.1	-0.2	5.1	-0.5
1997-5	0.582	2.7	2.8	-0.1	1.7	0.0
1997-6	0.593	-4.3	2.5	0.0	-1.5	0.6
1997-7	0.585	-11.3	1.7	-0.1	-4.7	1.5
1997-8	0.597	-20.5	1.3	-0.2	-5.9	2.0
1997-9	0.582	-28.7	-0.1	-0.4	-7.1	2.2
1997-10	0.605	-31.1	-1.1	-0.3	-5.1	-0.1
1997-11	0.594	-31.2	-1.3	-0.2	-3.7	-0.8
1997-12	0.595	-31.3	-1.5	-0.1	-2.3	-1.4

Notes:

1996-11	Official peak
1997-1	Official recession
	Probable recession
25.2	Peak signal
-10.4	Trough signal

** Probability of recession